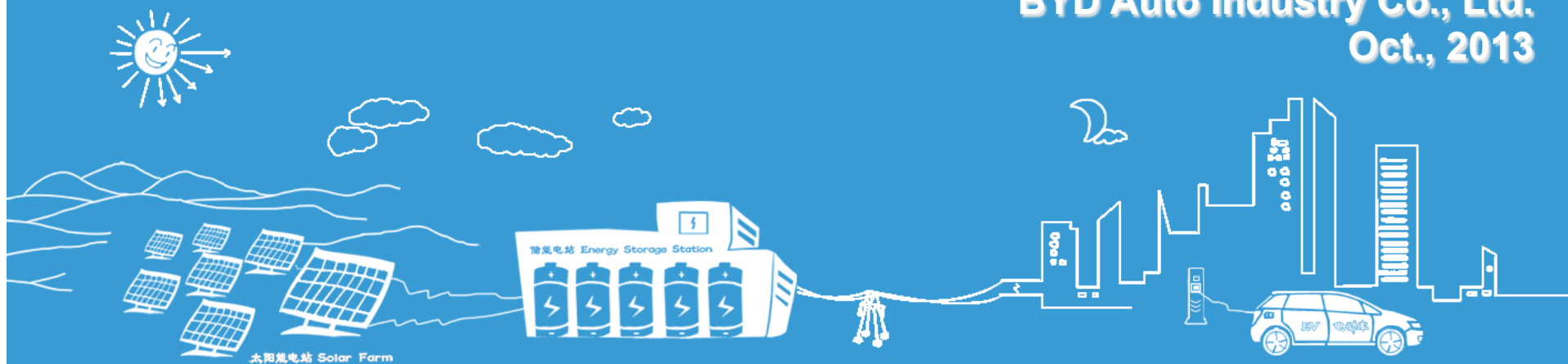




# Research of Battery Durability Performance

- Based on Lithium Ferrous Phosphate Battery

BYD Auto Industry Co., Ltd.  
Oct., 2013



*Build Your Dreams*



**Topic**



**Features of Battery Durability Performance**



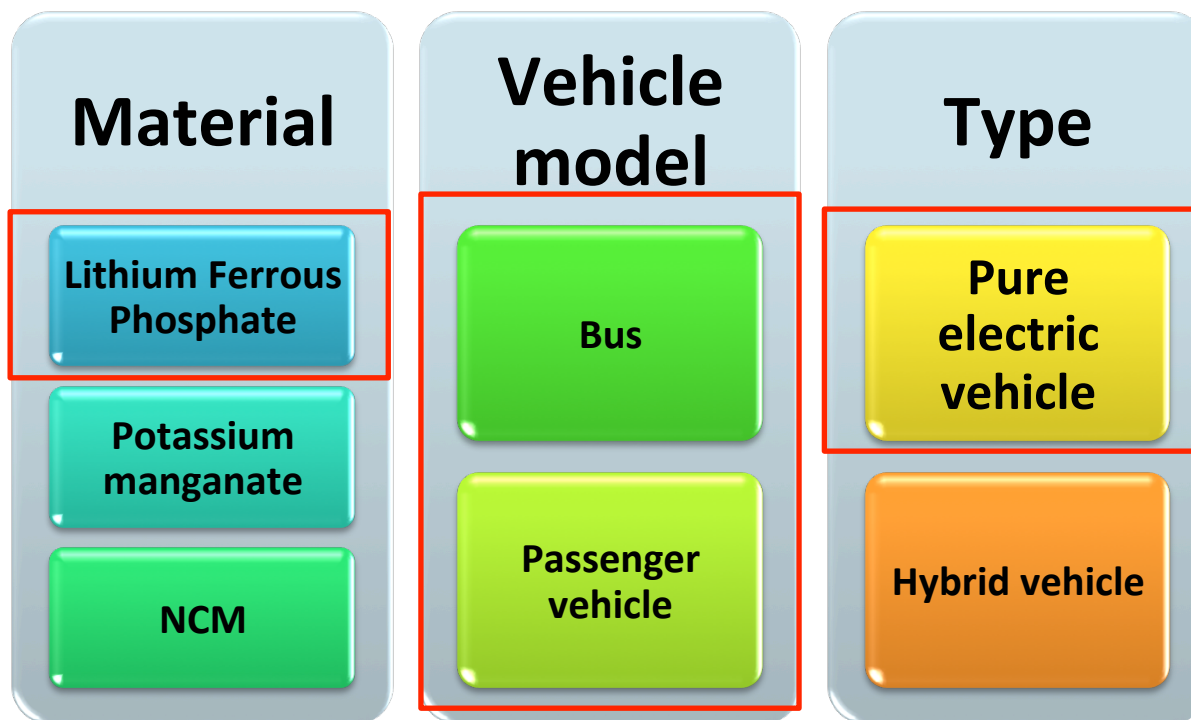
**Factors of Battery Durability Performance**



**Data of Current Vehicle Models**



## Testing category



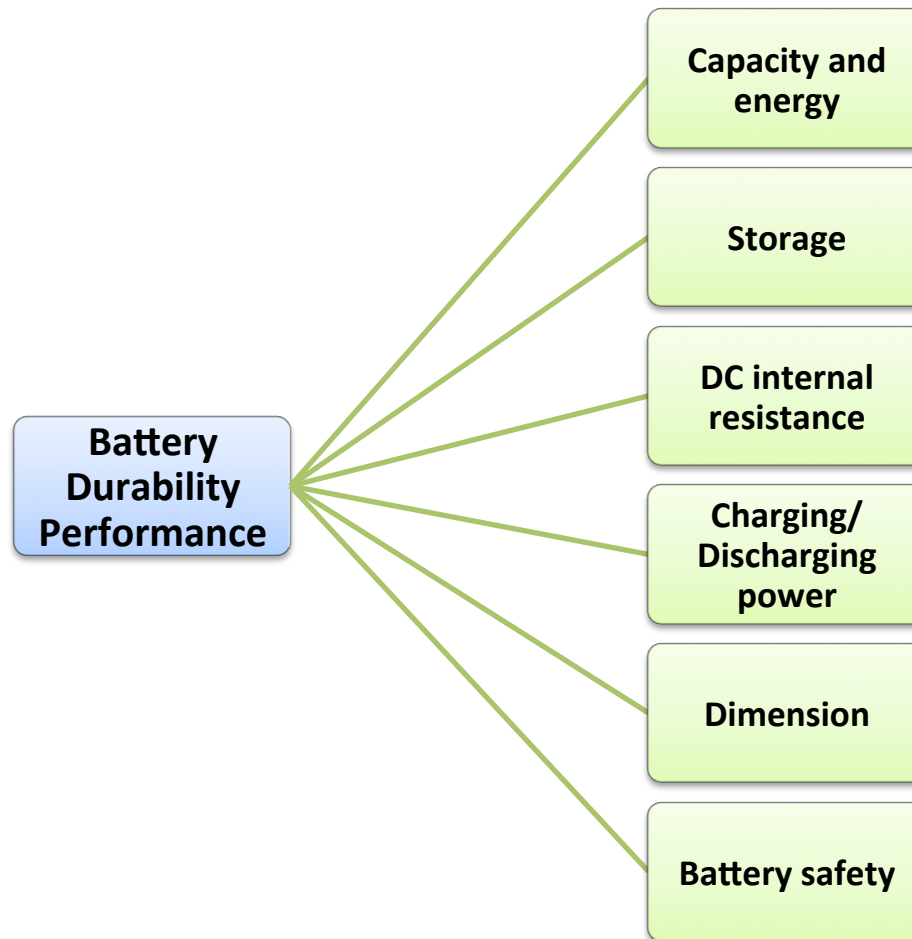
**BYD all research on Lithium Ferrous Phosphate Battery, implemented on vehicles as bus K9 (pure EV), passenger car e6 (pure EV)**



# Feature of Battery Durability Performance



Six aspects are considered regarding parameter of battery durability performance:

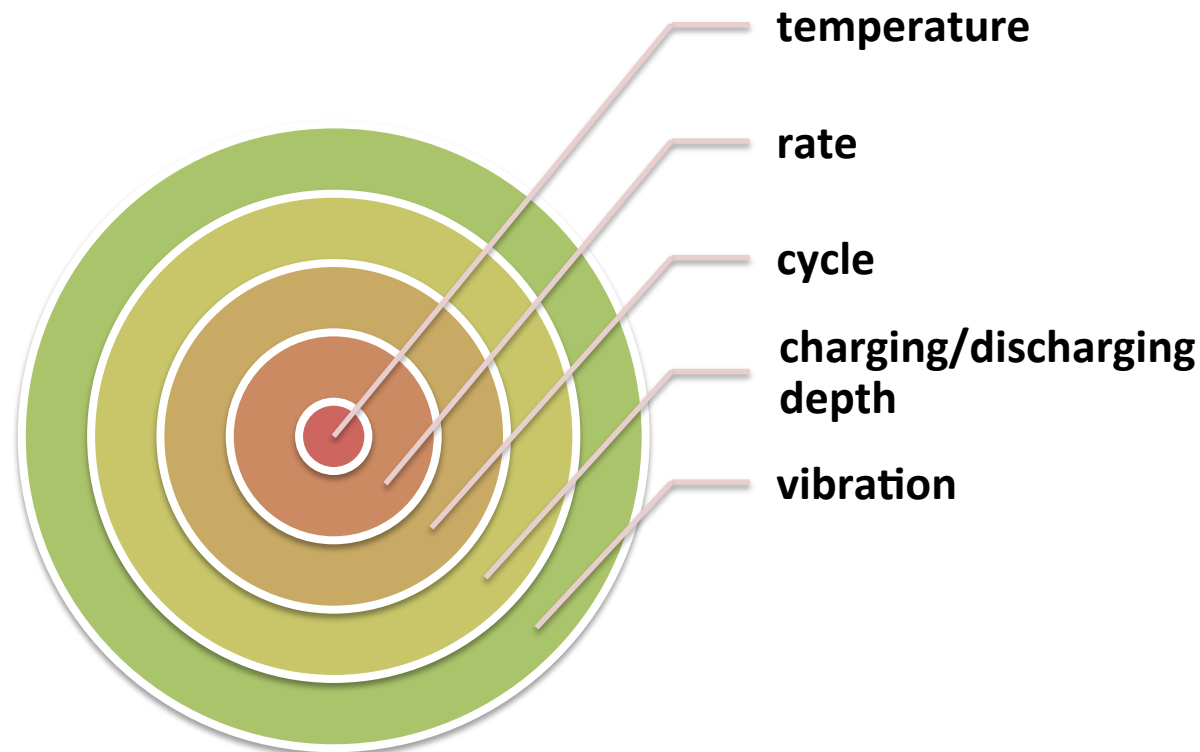




# Factors of Battery Durability Performance



Durability cycle testing shall be carried out based on five aspects below:

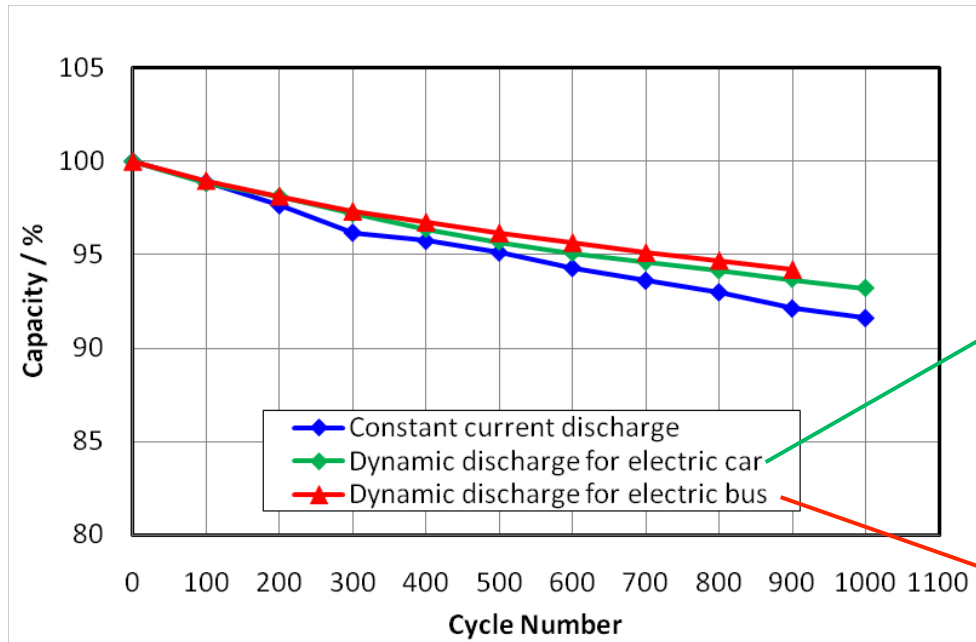


Different factors could influence each feature of battery durability performance and different batteries will also have different performance. In order to explain the researching method, following BYD research achievements will be presented for battery durability performance.



# Battery Durability Performance Research Case

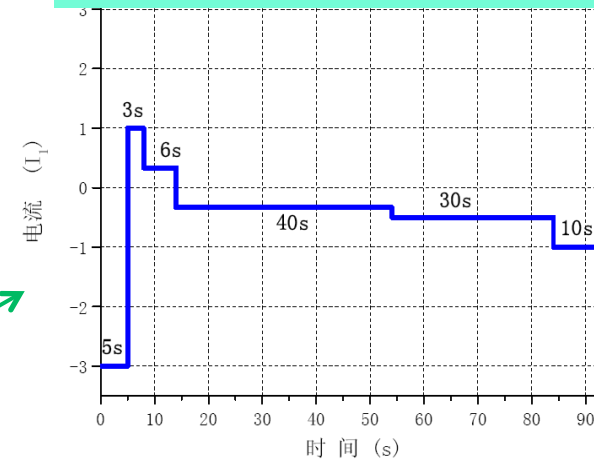
- Battery durability performance—capacity



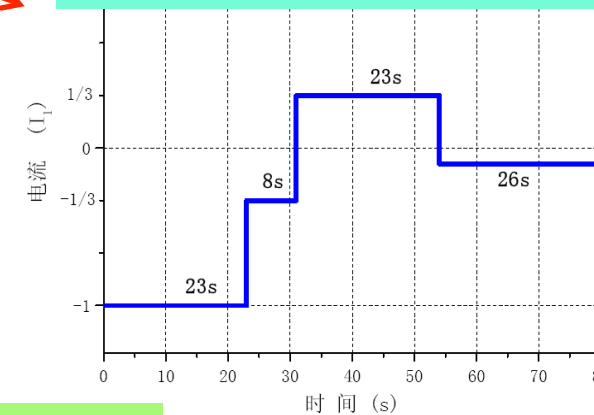
Room temperature (20°C ± 5 °C), testing cycle:

- Refer to Standard QC / T 743 Lithium battery for EV;
- Testing cycle: charge to 100% SOC with 0.5c constant current, and then implement cycle standard discharging till reaching cut-off voltage;
- With ratio of total output energy during cycles and initial energy, convert into the cycles times in the graph.
- Compare the influence to battery capacity fading under different cycle conditions with the same output energy.

Active discharging of pure electric sedan high energy density battery



Active discharging of pure electric bus high energy density battery

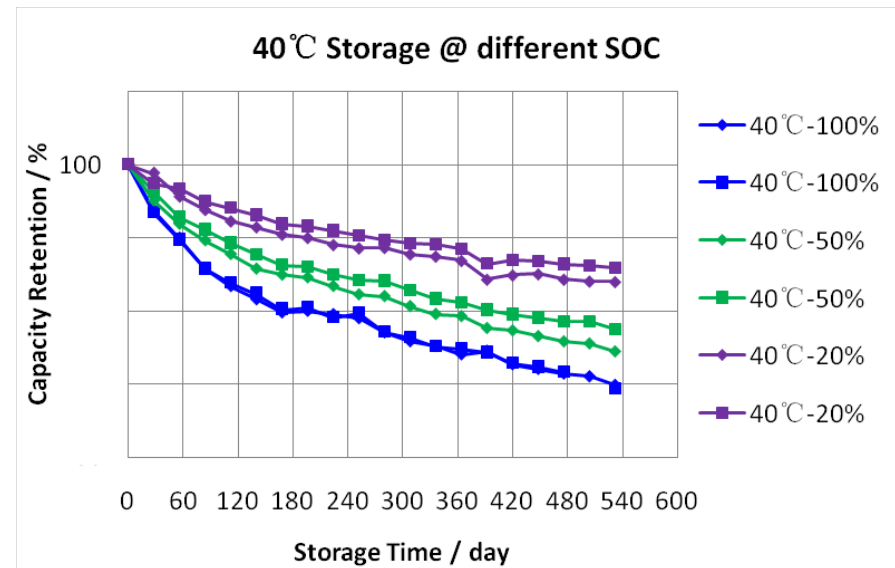
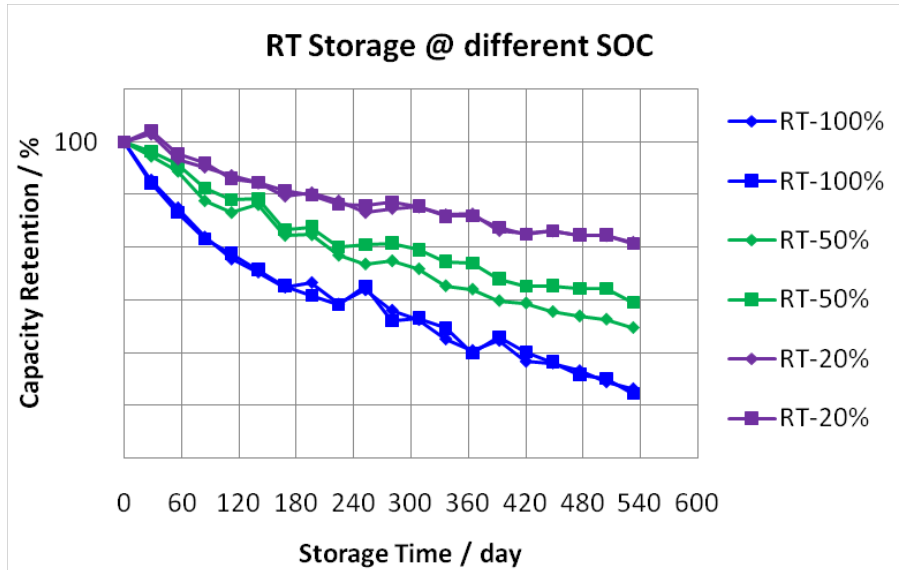


Battery cycle capacity fading is slightly slower than constant current cycle.



# Battery Durability Performance Research Case

- Battery durability performance—storage



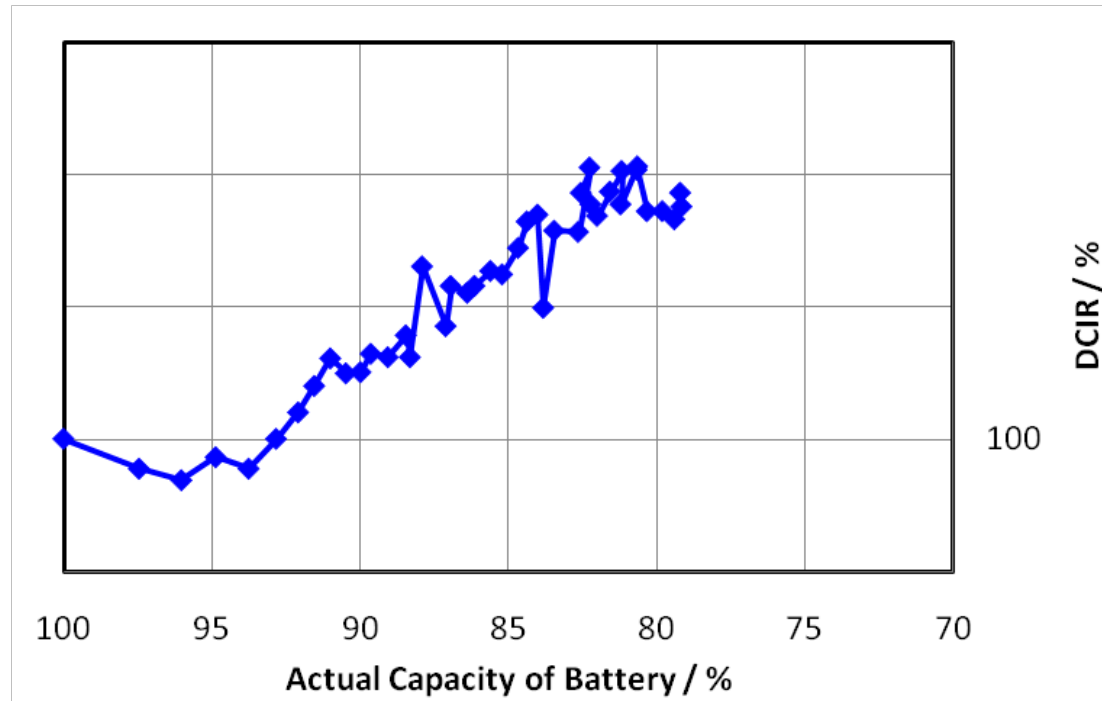
## Result analysis:

- Under certain condition, battery capacity decrease regularly with storage time increase;
- Under same storage temperature, capacity fading is faster when battery SOC is higher after storage;
- Under same SOC, capacity fading is faster when storage temperature is higher.



# Battery Durability Performance Research Case

- Battery durability performance—DC internal resistance (DCIR)



DCIR: when SOC is below 50%, voltage (produced when battery is discharging with 1.5C constant current for 30s) is divided by discharging current

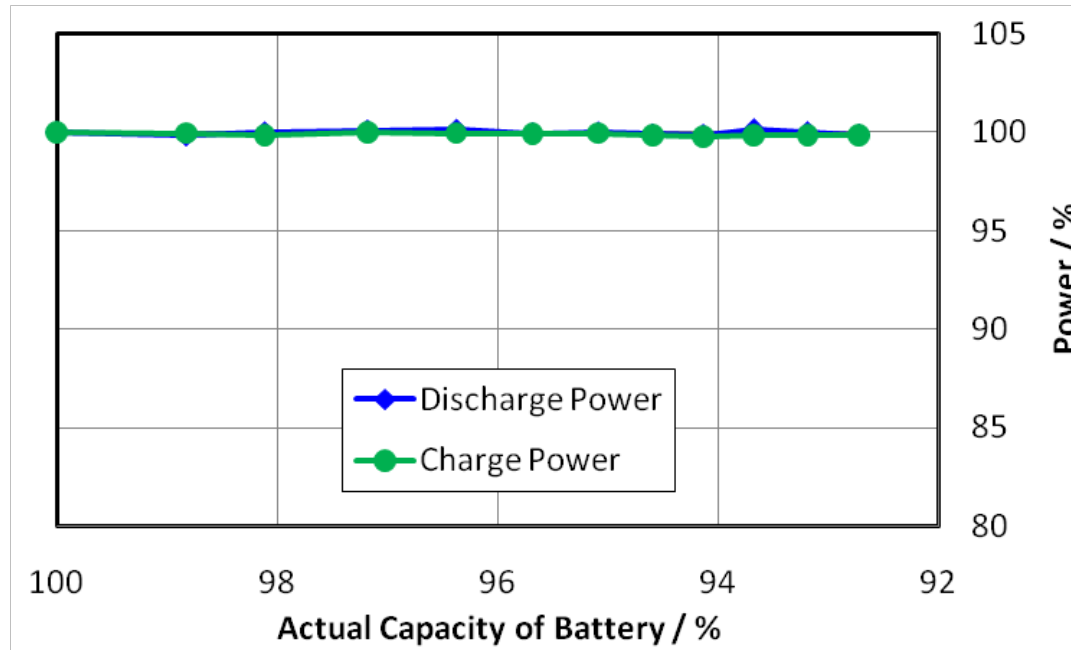
With battery capacity fading caused by cycles, battery DCIR changes regularly, also with big fluctuation.





# Battery Durability Performance Research Case

- Battery durability performance—power



Room temperature (20°C ± 5 °C ), testing cycle

- Refer to Standard QC / T 743 Lithium battery for EV;
- Testing cycle: charge to 100% SOC with 0.5c constant current, and then implement cycle standard discharging till reaching cut-off voltage;
- Power: SOC below 50%, it is the power produced when battery is discharging with 1.5C (300A) constant current for 30s.

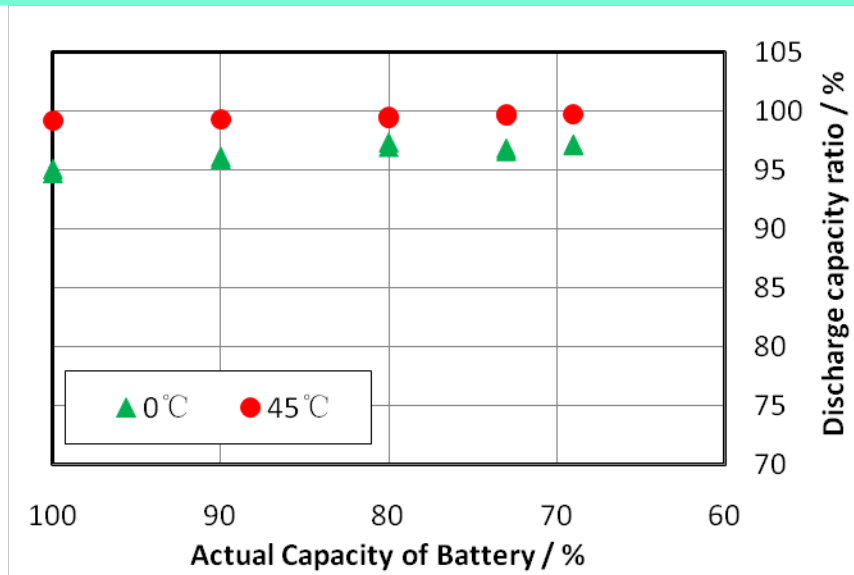
With cycle condition at room temperature, SOC below 50%, battery power does not change with battery capacity decrease.



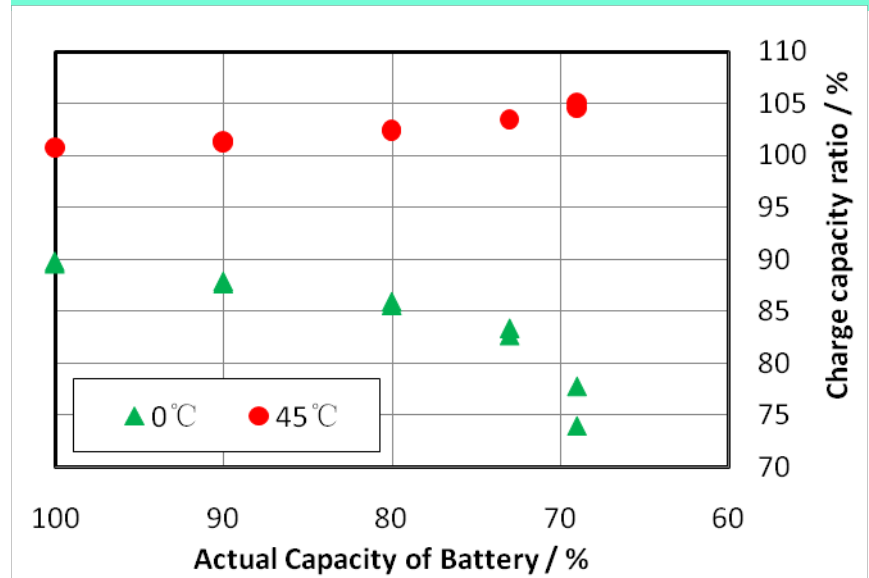
# Battery Durability Performance Research Case

- Battery durability performance—temperature

Discharging @ Different temperature: fully charged at room temp., then discharge after storage at different temp..



Charging @ Different temperature: fully discharged at room temp., then charge after storage at different temp..



Ratio of charging/discharging capacity at different temp. and capacity at room temp. changes with fading of battery capacity result analysis

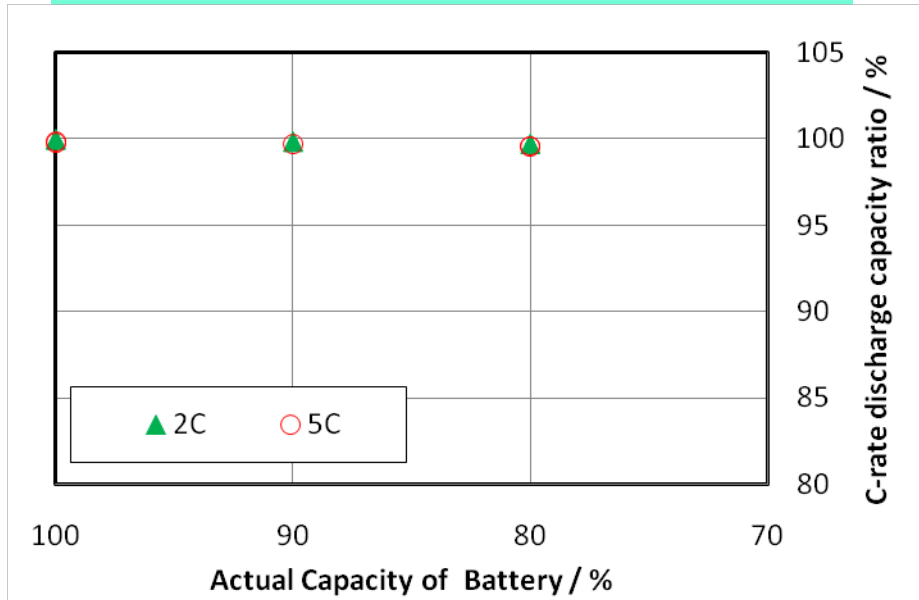
- 1、 Low temp. discharging capacity ratio gradually increase with fading of battery capacity, high temp. discharging ratio increase slightly with fading of battery capacity but not obvious.
- 2、 Low temp. charging capacity ratio gradually decrease with fading of battery capacity, high temp. charging ratio gradually increase with fading of battery capacity.



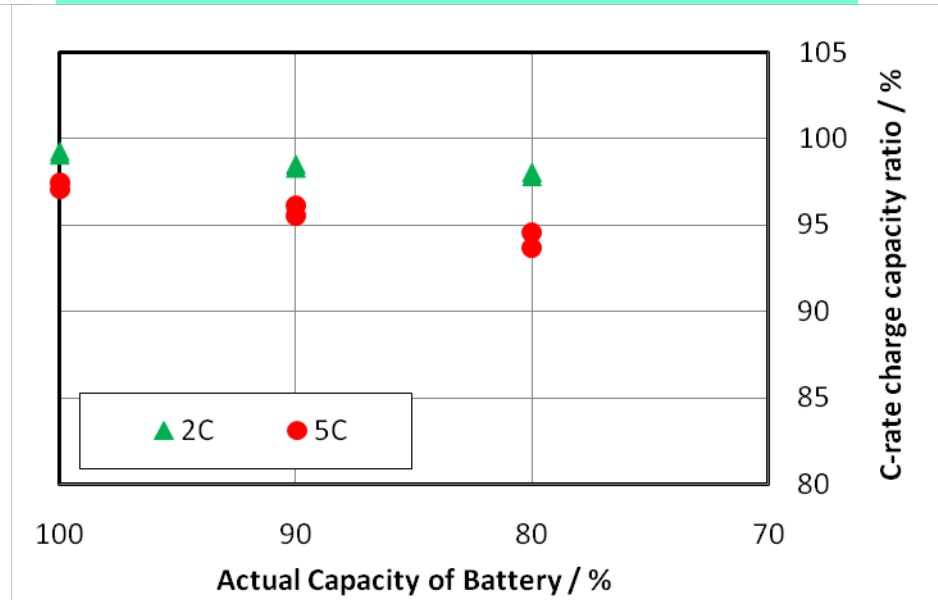
# Battery Durability Performance Research Case

- Battery durability performance—rate

Different rate discharging: fully charged at room temp., then discharge with different rate



Different rate charging: fully discharged at room temp., then charge with different rate

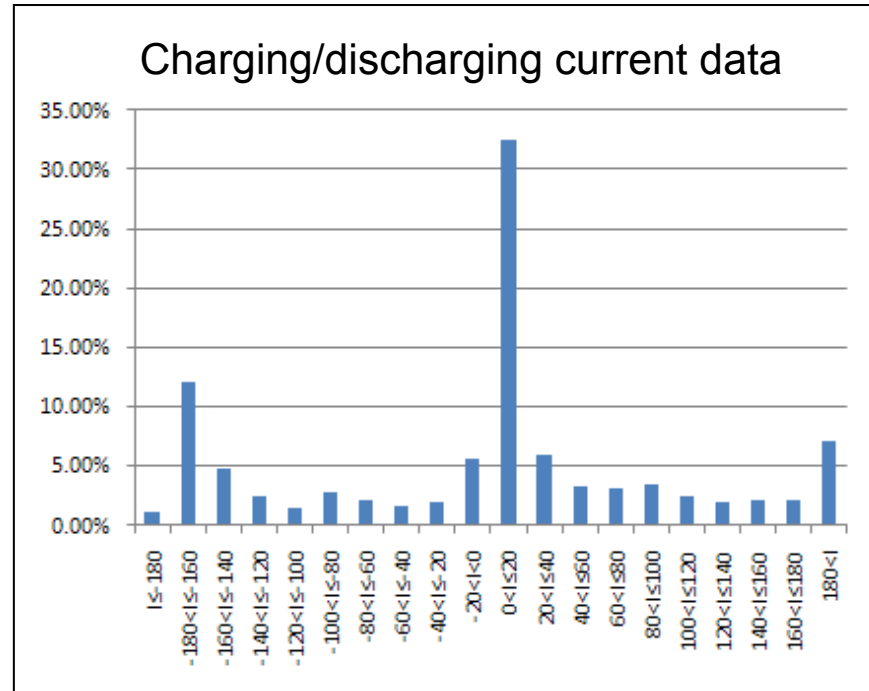


Ratio of different rate charging/discharging capacity and 0.5C capacity change with battery capacity fading result analysis:

- With battery capacity fading, battery capacity ratio almost remains the same .
- With battery capacity fading, battery capacity ratio decrease with rate increase when high rate charging



# Data of Current Vehicle Models—Pure E-Bus



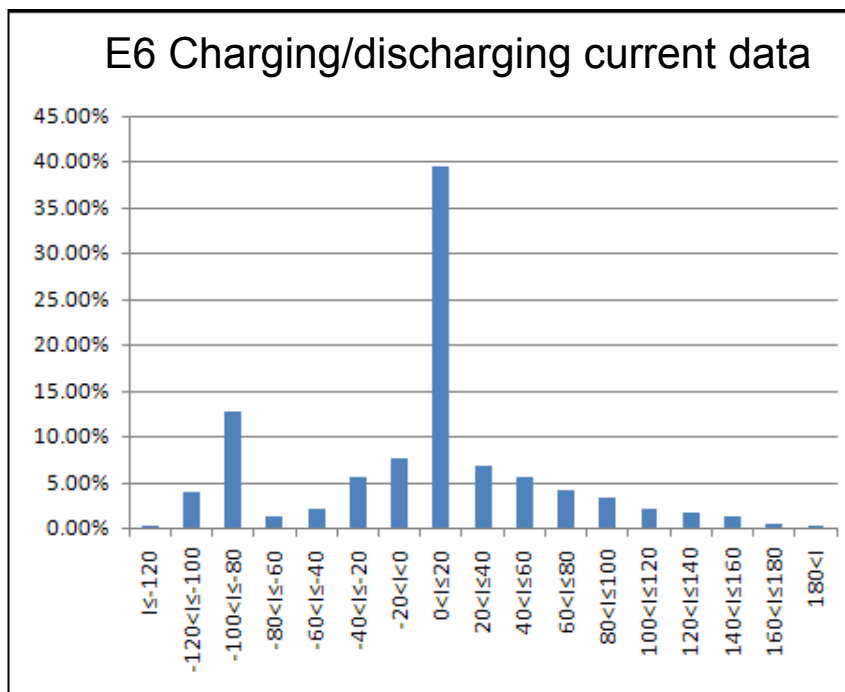
## Analysis:

After investigating charging /discharging current data of five BYD buses from Shenzhen area for three months, charging/discharging current diagram above was derived. Data above was categorized into several levels below:

Charging rate	Ratio	Discharging rate	Ratio
1/3C	18%	1/3C	11%
1/6C	9%	1/6C	11%
1/15C	9%	1/15C	42%



# Data of Current Vehicle Models—Pure Electric Passenger Vehicle



## Analysis:

After investigating charging /discharging current data of five BYD passenger vehicles (Taxi) from Shenzhen area for three months, charging/discharging current diagram above was derived. Data above was categorized into several levels below (200AH cell):

Charging rate	Ratio	Discharging rate	Ratio
1/5C	15%	1/5C	52%
1/2C	19%	1/2C	12%
1C	/	1C	2%



非常感谢!  
Thank You!



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